Communications Protocol

Data acquisition and control of Axium equipment is performed by home automation systems or personal computers using a special protocol developed by Axium. This document explains the protocol itself and the low level transport.

1. Transport

1.1. RS-232

The lead must be a straight wired cable, except on the AX4752 and prior models this was a “null modem”, which is a 9 pin female ‘D’ connectors at both ends (pin connections 2 and 3 swapped at one end). **Only RX, TX & 0V (pin 5) are used.** Baud Rate = **9600.**

Each byte in the command is encoded into two ASCII encoded hexadecimal characters. A line feed signals the end of the command. The carriage return that is typically used in combination with the line feed is optional and is ignored. XON and XOFF (characters 11h and 13h) are used for flow control where the XOFF state times out after approximately 1.5 seconds in order to prevent an inadvertent system lock up.

If the device that is receiving a command is capable of transmission, it should transmit the command back to the originator. This is required because of connection issues with RS-232. For example a PC's TX is connected to an amplifier's RX and the amplifier's TX is connected to a keypad and the PC's RX. For the PC to communicate successfully with the keypad, all that arrives on the amplifier's RX must be sent back out its TX. To avoid possible endless cycles, the device originally sending a command must ignore the command if it is received again.

1.2. USB

Previously the CDC class (abstract control model) was employed to emulate RS-232, enabling software to interact with devices supporting USB theoretically without need of change. However from the AX-800DAV onwards a proprietary protocol is in use.

1.3. Axium Bus

The Axium bus is based on the I²C bus and allows multiple devices to be attached to a common bus. All transmissions are performed using multi-master mode and take the following form:

<start bit><address byte><command data><stop bit>

The address byte is a requirement of the I²C bus. 7 bit address mode is used and the R/W bit is always 0 (always writing). Address 30h is used for the Axium protocol (02h was used by older devices until this address was declared as being reserved). Other addresses are used such as 3Ah (for Ethernet packets) and 20h (for transmission preambles to ensure collision free access to the bus). Other devices using different protocols can be connected to the Axium bus if they use different addresses and support multi-master mode.

1.4. Infrared

The infrared interface allows Axium devices to be controlled using the Axium Communications Protocol. It is not suitable for two-way communications unless combined with RS232 or the Axium bus.

The modulation frequency is 44.1 kHz and all bursts of IR are 1ms in length. The length of the pauses between the IR bursts is what contains the data. The first pause is 3ms and represents the start bit. All following pauses are either 1ms or 2ms, which represent logic 0 and logic 1 respectively. Each IR stream takes the following form:

<start bit><product ID><command data><checksum><stop bit>

The product ID is a three bit code and is 001 for Axium Amplifiers.

The checksum is built using the command data: the sum of each byte in the command plus the checksum must equal zero. The stop bit is represented by a 15ms pause before there is any further IR activity. A receiver can however decide as soon as 4ms after IR activity has ceased that the packet is complete.

1.5. Ethernet

On Ethernet equiped devices, commands can also be sent via Ethernet in the same format as RS232 commands to TCP port 17037. However unlike RS232, commands sent to the device are not echoed back. A telnet session can be used for experimentation purposes.

2. Command Protocol

Command structure: <**command**><**zone**>[<**data**>[<**data**>[**...**]]]

Command:

The command byte can have the following values:

Command (Hex Value)	**Description**
00	No Operation
01	Standby
02	Mute
03	Source Selection
04	Volume
05	Bass
06	Treble
07	Balance
08	Request Protocol Version
09	Send All Parameters
0A	Report Error
0B	Emulate key press on Keypad
0C	Amplifier special features
0D	Maximum Volume Limit
0E	Preset Selection / Status (deprecated)
0F	Link zone pair (deprecated)
10	Unsupported IR command received
11	Volume Up
12	Volume Down
13	Amp Source - Keypad Bank Assignment
14	Request Device information
15	Erase Memory
16	Request all IR function definitions (deprecated)
17	IR function definition (deprecated)
18	Keypad set-up
19	Request keypad set-up
1A	Local Time (deprecated)
1B	Preset Parameters
1C	Zone Name
1D	Preamplifier Volume Mode
1E	Preset Selection / Status
1F	Report Key press in preset
20	Local Date (deprecated)
21	Request amp source - Keypad Bank Assignments
22	Request device log entry
23	Preset alarm control
24	Request PCM capabilities
25	PCM stream
26	Volume BCD format
27	Set time zone, date and time
28	Video source selection
29	Source Name
2A	Preset Name
2B	Request preset name
2C	Source Up
2D	Source Down
2E	Zone assignment
2F	Request zone assignments
30	Link zones
31	Audio delay

32	Source Gain
33	Page Preset 2 Selection
34	Clipping notification
35	IR routing assignments
36	Party mode select/deselect
37	Party mode configuration
38	Zone name request
39	Request extended device information
3A	Network settings
3B	Media servers
3C	List sources
3D	Extended source play control
3E	Play status notification
3F	Play status request
40	Report message
41	Request time
60 – 6F	Reserved (undocumented commands)
70 – 7F	User defined commands
80 + command value	Command Response

The commands are also used as notifications. If an amplifier is switched on by pressing the standby button on the amplifier's front panel, it will notify the other devices by sending the standby command. Any other amplifiers on the same zone will take the notification as a command and also switch on. This can be used for synchronising two amplifiers.

Zone:

This byte is used for checking if the command is applicable to the device receiving the command and if so, for optionally selecting a "sub-device", e.g. a bank or part of a device.

The lower 5 bits of the zone byte equal **00 – 1F** for zones 0 to 31. The upper 3 bits can represent a sub-zone or extended zones. FF is used for addressing all zones and can be used for turning all amplifiers on, for example. The sub-zone codes for the AX4750I and AX4752 amplifiers are as follows:

000 standard amplifier
001 page preset amplifier - add 20 Hex
010 standard preamplifier - add 40 Hex i.e Zone 1 Preamp = 41, Zone 10 Preamp = 4A
011 page preset preamplifier - add 60 Hex.

On the video switcher bits 6 and 7 are used for an extra 64 zones. Bits 5..7:

000 common zone range (0..31)
100 extended zones 32..63
110 extended zones 64..95

Data:

Some commands use a unique 16 bit device ID, which is assigned to the device during manufacturing. The number of data bytes is dependent on the command. The maximum number of data bytes should be restricted to 20. If a multi-byte parameter containing large numbers (e.g. the device ID) then the left most bytes in the string (the ones received first) are the most significant (big-endian format).

If fewer than the expected number of data bytes are received, the AX-800-DAV and later devices treat the command as a request and will return the requested data.

Command	**Data field length**	**Content** (Hex value)
Standby (**01**)	1 byte	**00** Standby A off **01** Standby A on **02** Standby B off

		03 Standby B on **04** Toggle standby A **05** Toggle standby B **06** Standby A and B off **07** Standby A and B on Standby B only applies to the AX50i and AX250i.
Mute (**02**)	1 byte	**00** mute **01** unmute **02** toggle mute
Source Selection (**03**)	1 byte	**00** select S5 (CD) **01** select S6 (Tape) **02** select S7 (Tuner) **03** select S4 (Aux) **04** select S8 (Utility) **05** select S1 (SAT) **06** select S2 (DVD) **07** select S3 (Video) **08 .. 0F** select S9..S16 **10** USB host **11** Internet radio **12** Media Player **13** PCM playback Bit 5 is reserved and should be set to 0. Bit 6 is set if Video source is not to be switched, i.e. **40** select S5 (CD) audio only **41** select S6 (Tape) audio only **42** select S7 (Tuner) audio only **43** select S4 (Aux) audio only **44** select S8 (Utility) audio only **45** select S1 (SAT) audio only **46** select S2 (DVD) audio only **47** select S3 (Video) audio only **48 .. 4F** select S9..S16 audio only Bit 7 is set to turn the zone on.
Volume (**04**)	1 byte	**00 – A0** (0 – 160)
Bass (**05**)	1 byte	**F4 – 0C** (-12 – 12)
Treble (**06**)	1 byte	**F4 – 0C** (-12 – 12)
Balance (**07**)	1 byte	**EC – 14** (-20 – 20)
Request Protocol Version (**08**)	0 bytes in command, 1 byte in response	**01** in response for the current version
Send All Parameters (**09**)	0 bytes	
Report Error (**0A**)	1 byte or 4 bytes	**00** no error Amplifier errors: **01** no acknowledge **02** SCL line stuck low **03** SDA line stuck low **04** bus not free **05** overflow in register **06** overflow in receive buffer **07** receive aborted **08** write collision Keypad errors:

		10 frequency error **11** too many different period lengths **12** IR function too long **13** compressed IR function too long **18** EEPROM comms error **19** EEPROM erase error **1A** EEPROM full In case four bytes of data are transmitted, 2nd byte is an extra information byte for the error, 3rd and 4th bytes are the device ID.
Emulate key press on Keypad (**0B**)	1 byte	Keypad key code (as shown below) in lower 5 bits, number of repeats in upper 3 bits. **FF** means stop repeating the current key.
Amplifier special features (**0C**)	1 byte	Bit 0 = loudness enable Bits 1..3 = display brightness where 0 is brightest (AX250i and AX450i only) Bit 4 = Preamplifier controls Ampon signal when set, otherwise the amplifier controls Ampon. Bit 5 = Ampon control supported when set. Bit 6 = Sound played back on page preset. Deprecated, use the flag in the Preset Parameters command. Bit 7 = Sound playback enable supported when set.
Maximum volume (**0D**)	1 byte	**00 – A0** (0 – 160)
Preset Selection / Status (deprecated) (**0E**)	1 byte	Bits 0-3 command the preset selection: **0** = default (page preset input selects between standard and page preset modes) **1** = select standard mode **3** = select page preset mode **4** = select preset 1 **5** = select preset 2 **6** = load preset 1 parameters **7** = load preset 2 parameters Bits 4-7: current preset status: **0** = standard mode **1** = page preset **2** = preset 1 **3** = preset 2
Link zone pair (deprecated) (**0F**)	1 or 2 bytes	Zone to be linked to the command's zone. **FF** for no zone linking. Otherwise 0..95 This command always links a pair of zones. It is not possible to link more than two zones together but there is no restriction on the number of linked zone pairs. The second byte specifies options for the zone linking: • Bit 0 is set for source linking • Bit 1 is set for volume linking • Bit 2 is set for standby (power on/off) linking If no second byte is received then only source tracking is the default. Volume linking also implies mute and Amp/Preamp volume tracking mode and offsets are also synchronised. See the Notes section for more information.
Unsupported IR command received (**10**)	1 byte	The command received. This can be used for controlling other devices using the amplifier as an IR receiver.
Volume Up (**11**)	0 bytes	**00** (value ignored)
Volume Down (**12**)	0 bytes	**00** (value ignored)
Amp Source -	3 bytes	First two bytes are the device ID followed by one byte where the

Keypad Bank Assignment (**13**)		upper 4 bits is the amplifier source and the lower 4 bits are the keypad bank. If the upper 4 bits are all set (**F**), the assignment is deleted for the bank.
Request Device information (**14**)	0 or 1 bytes in command, 5+ bytes in response	Request: if a data byte exists, bit 0 is set if devices should not reply on the Axium bus. This enables information retrieval of devices directly connected to a serial port, usb, etc. If bit 1 is set devices should only reply on the port that received that command. This prevents flooding the stack with responses. Response: First byte is the device type. Second byte is the firmware version. Third byte is device specific information. Fourth & firth bytes are a unique ID for the device (MSD first). If more than 5 bytes are returned, the remaining data are specific to the type of device.
Erase memory (**15**)	2 bytes in command, 3 bytes in response	Command contains the device ID. Response returned immediately with device ID plus **00** and then after erasing with device ID plus **01**.
Request all IR function definitions (deprecated) (**16**)	2 bytes in command, 4 bytes in response	Request contains device ID, receiver responds first replies with its device ID plus the number of function definitions (macros counted as one definition). First byte upper 8 bits, second byte lower 8 bits. Then it sends all the definitions.
IR function definition (deprecated) (**17**)	Max. 19 bytes, 2 bytes in response	First three bytes is the device ID plus the number of bytes already transmitted for the IR function. Remaining bytes are defined below under “IR Function Definition”. Response is returned with the device ID when the definition has been received.
Keypad set-up (**18**)	5 bytes, 2 bytes in response	• Device ID (2 bytes) • Zone to which the keypad listens when not in network program mode. Upper bit is set for responding to standby B. • LED settings: ○ KRXm: Back lighting brightness (upper 4 bits) and duration (lower 4 bits) ○ AX-KPB: bits 0..1 source LED brightness (0 = 25%, 1 = 50%, 2 = 100%), bits 2..3 volume LED brightness (0 = off, 1 = 50%, 2 = 100%) bits 4..5 backlighting brightness (0 = off, 1 = 25%, 2 = 50%, 3 = 100%) bit 6 backlight duration (0 = timed, 1 = continuous) • Bit 0 is IR receiver enable Bit 1 is Beeper enable Bit 2 is Amp/Preamp zone toggle mode. Response contains the device ID.
Request keypad set-up (**19**)	2 bytes	Device ID of the keypad to query.
Local time (deprecated) (**1A**)	4 bytes	• Hours (0..23 decimal) • Minutes (0..59 decimal) • Seconds (0..59 decimal) • Weekday (0 = Sun, 1 = Mon, .., 6 = Sat)
Preset Parameters (**1B**)	12 - 24 bytes	Like the preset select command, this command should be sent to all zones. The first byte is the preset to set up using the same constants as the preset select command, where preset 1 = 2. 10h can be used for specifying settings for the preset used by the second page contact. Three bytes for the auto activation schedule in local time: • Hour (0..23) • Minute (0..59)

		• Weekdays (bit 0 = Sun, bit 1 = Mon, .., bit 6 = Sat). Bit 7 is set to deactivate auto activation. 8 bytes for the zone selection: lower 32 bits (last 4 bytes) represent the 32 zones for the amp rooms, upper 32 bits represent the 32 zones for the Preamp rooms. Optionally 3 more bytes for DND (do not disturb). First two bytes are the time window (time from, time to) where bits 2..6 represent the hour and bits 0..1 represent the minute in quarter hour resolution (minute in {00, 15, 30, 45}). The third byte represents the preset to substitute when inside the time window (where preset 1 = 2). Set to 0 when DND is unused. DND is only supported for page presets. Optionally 1 byte for flags: • Bits 0..1 preset sound selection (4 sounds) • Bit 2 enables sound playback on preset activation by contact closure (page presets). • Bit 3 enables sound playback on preset activation by Preset Selection command. • Bit 4 enables sound looping Optionally 8 bytes for zone 32..95 selection.
Zone name (**1C**)	Unlimited	Data field contains the string. Character encoding is UTF-8.
Preamp volume mode (**1D**)	1 byte	A signed number in the same units as the volume command. –128 (**80h**) represents independent mode, otherwise tracking mode is specified and the offset is equal to Preamp – Amp volume.
Preset Selection / Status (**1E**)	1 or 2 bytes	Supports up to 15 presets (including page preset) and is intended to always be transmitted to all zones (zone byte should be **FF**). 1st byte commands the preset selection: **00** = default (page preset input selects between standard and page preset modes) **01** = force page preset mode **02** = select preset 1 **03** = select preset 2 ... **0F** = select preset 15 **10** = select preset assigned to the second page contact Bit 7 selects the preset load function, which loads the preset settings but stays in non-preset mode. Bit 6 selects sound playback. Bit 5 locks all settings when set. Prevents inadvertent changes to the preset via front panel, IR or otherwise. 2nd optional byte specifies the current preset status: **00** = standard mode **01** = page preset selected **02** = preset 1 selected **03** = preset 2 selected … **FF** = unspecified
Report key press in preset (**1F**)	1 byte	Same as the “Emulate key press on Keypad” command except that this is only used for reporting the keys in a preset macro for information only.
Local date (deprecated) (**20**)	4 bytes	• Day (1..31) • Month (1..12) • Year (0..255, where 0 = 2000) • Weekday (0 = Sun, 1 = Mon, .., 6 = Sat)
Request amp source to keypad bank assignments (**21**)	2 bytes	Device ID. The keypad then sends all its assignments.

Request device log entry (**22**)	3 - 5 bytes in request, 11 or more bytes in response when entry exists, 4 bytes when not.	Request contains: • Device ID (2 bytes) • Log entry ID low byte • Log entry ID high byte (optional) • Number of entries to return (optional) Responses are returned with: • Device ID (2 bytes) • Log entry ID low byte (1 byte) • Log entry type (1 byte), FFh for no entry • Hour (0..23) • Minute (0..59) • Second (0..59) • Weekday (0 = Sun, 1 = Mon, .., 6 = Sat). Lower 3 bits only. • Day (1..31) • Month (1..12) • Year (0..255, where 0 = 2000) Further bytes may be sent as parameters. The number and format depend on the log entry type. Multiple responses are returned if the request asks for more than 1 log entry.
Preset alarm control (**23**)	2 bytes	Like the preset select command, this command should be sent to all zones. The first byte is the preset to set up using the same constants as the preset select command, where preset 1 = 2. **FF** means all presets. The second byte has the following meanings: • **00** : disable alarm • **01** : enable alarm • **02** : sleep (re-activate alarm in 5 minutes)
Request PCM capabilities (**24**)	3 bytes in request, 10 or more bytes in response	Request: • Device ID (2 bytes) • Purpose (1 byte) Response: • Device ID (2 bytes) • Purpose (1 byte) • Available memory (4 bytes) • Max packet size (2 bytes) • Supported format (1 byte) • [Additional supported formats]
PCM Stream (**25**)	8 bytes in request header, 7 bytes in response (3 bytes before AX-800DAV)	Request: • Device ID (2 bytes) • Purpose (1 byte) • Format in first packet, otherwise **00** (1 byte) • Length of stream in first packet, otherwise position in stream (4 bytes). Always **0000** if a continuous stream. • PCM data Response: • Device ID (2 bytes) • Purpose (1 byte) • Position in stream (4 bytes)
Volume BCD format (**26**)	1 byte	**0 – 99** in BCD format Deprecated – do not use.
Set time zone, date and time (**27**)	19 bytes	• Standard time offset in minutes (2 bytes) • Daylight saving time (DST) offset in minutes (2 bytes) • DST to standard time changeover month (1..12) • DST to standard time changeover week (1 = first week in month, 2 = second week, 5 = last week in month) • DST to standard time changeover weekday (0 = Sun, 1 = Mon, .., 6 = Sat) • DST to standard time changeover hour (0..23) • Standard time to DST changeover month

		• Standard time to DST changeover week • Standard time to DST changeover weekday • Standard time to DST changeover hour • Hour (0..23). Bit 7 set if in DST, bit 6 set if standard time. If neither bit is set, time is local time (either DST or standard time). • Minute (0..59) • Second (0..59) • Weekday (0 = Sun, 1 = Mon, .., 6 = Sat). Lower 3 bits only. • Day (1..31) • Month (1..12) • Year (0..255, where 0 = 2000) The offset values are 16 bit signed values in minutes (high byte first). The following rule applies: local time = UTC + offset If no daylight saving applies, all changeover parameters are 0. Changeover times are in the standard local time.
Video Source Selection (**28**)	1 byte	**00** select S5 (CD) **01** select S6 (Tape) **02** select S7 (Tuner) **03** select S4 (Aux) **04** select S8 (Utility) **05** select S1 (SAT) **06** select S2 (DVD) **07** select S3 (Video) **08 .. 0F** select S9..S16
Source Name (**29**)	Min 4 bytes	First byte is the source ID (00 – 0B). Bytes 2 – 4 represent a short name of up to three characters. If the name is shorter than three characters, the remaining bytes are set to 00. After the short name an optional long name can be specified. Character encoding is UTF-8.
Preset Name (**2A**)	Min 1 byte	The first byte is the preset to set up using the same constants as the preset select command, where preset 1 = 2. Following bytes is the preset name. Character encoding is UTF-8.
Request preset name (**2B**)	1 byte	The preset to set up using the same constants as the preset select command, where preset 1 = 2. The response is the “Preset Name” command.
Source Up (**2C**)	1 byte	**00** audio source up with video source sync **01** audio source up **02** video source up
Source Down (**2D**)	1 byte	**00** audio source down with video source sync **01** audio source down **02** video source down
Zone assignment (**2E**)	2+ bytes	Device ID followed by a list of zone numbers
Request zone assignments (**2F**)	0 or 2 bytes in request, *n* bytes in response	Request: device ID of device to request the zones from. If no device ID is specified, the device receiving the command will answer and the command will not be relayed to another interface. Response: device ID followed by a list of zone numbers.
Link zones (**30**)	2+ bytes	Replaces the “link zone pair” command (0F) and can link any number of zones into a group. This command should be sent to all zones (zone byte = FF). The first byte specifies the options for the zone link group: • Bit 0 is set for source linking • Bit 1 is set for volume linking • Bit 2 is set for standby (power on/off) linking • Bit 7 is set if the list of zones is preceded by a 4 byte group identifier.

		The remaining bytes list the zones in the group and are in {0..95}. Zones can be removed from the group by defining new groups which exclude the zone or by defining groups which contain only the zone to exclude. Similarly if a group contains {A, B, C, D} and a new group is defined containing {A, C} then {B, D} will remain in the original group. A zone cannot belong to more than one group. Zone groupings are not affected by presets.
Audio delay (**31**)	1 byte	Output delay of audio stream in 5ms steps. 00 = no delay.
Source Gain (**32**)	2 bytes	First byte is the source ID (00 – 0B). Second byte is analogue input gain **F4 – 0C** (-12dB – +12dB).
Page Preset 2 Selection (**33**)	1 byte	The preset to be selected when the second page contact is closed. Sent to all zones.
Clipping notification (**34**)	2 bytes	First byte is type of clipping event. The second byte is information pertaining to the event. The following events are currently defined: • 01 – analogue input clipped. The following byte represents the source that is clipped. • 02 – analogue input unclipped.
IR routing assignments (**35**)	6+ bytes 3 bytes in request	First two bytes is the unit ID. Third byte is the IR source (keypads, bus run, expansion bus, etc). Numbered from 0. Fourth byte is the zone to monitor for source selection in {0..95}. Then for each source starting from S1, two bytes which represent a bitmap of IR output enables. IR output 1 is at bit 0, IR sum output follows bit for last output, expansion bus follows bit for IR sum output. If the IR source is the expansion port, the zone is ignored and only two bytes for the IR output enables is used. Sent to all zones.
Party mode select/deselect (**36**)	1 byte	00 = deselect party mode (selects standard mode) 01 = select party mode The party mode selection is stored in presets so that presets can activate or deactivate this mode. Sent to all zones.
Party mode configuration (**37**)	3 bytes	First two bytes is the unit ID of the party master. Third byte is the source selected for its party mode output. Sent to all zones.
Zone name request (**38**)	0 bytes	Requests the zone name.
Request extended device information (**39**)	2 bytes in command, response length is device specific	Command: two bytes for the unit ID. Response for AX-800DAV: • 4 bytes for 32 bit unit ID where bytes 3-4 match the standard 16 bit unit ID. • 3 bytes for firmware version: major, minor and beta version (0 for release versions). • 1 byte current temperature (signed). • 1 byte peak temperature (signed). • 4 bytes for IP address. • 6 bytes for MAC address. • 3 bytes manufacture date: year (0..255 = 2000..2255), month (1..12), day (1..31)
Network settings (**3A**)	Minimum 3 bytes	Two bytes for the unit ID, followed by name type ID which is followed by the name. Name type IDs: • 01h = Network name • 02h = Time server name • 03h = 1 byte flags where bit 0: 0 = DHCP, 1 = Static, bit 1: 0 = Time server disabled, 1 = Time server enabled. 16

		bytes IP addresses (4 bytes per address): IP address, subnet mask, DNS server, default router. • 81h = Request network name • 82h = Request time server name • 83h = Request IP addresses and flags Sent to all zones.
Media servers (**3B**)	Minimum 3 bytes	Two bytes for the unit ID, one byte for list entry index, followed by strings for UNC path, user name and password. Each string is null terminated. No strings are listed for last entry in the list. The list entry index begins at 0 and is FFh to request the list. Entries must be sent in ascending order.
List sources (**3C**)	0 bytes to query sources.	Lists the available sources on the zone. Notifications are sent if the available sources change.
Extended source play control (**3D**)	2+ bytes	First byte is the source ID followed by play control command and command dependent data: 01 = Play. Next two bytes is an optional 16 bit track index, numbered from 0. 02 = Pause/Resume 03 = Stop 04 = Previous track 05 = Next track 06 = Set repeat mode. Next byte: 0 = no repeat, 1 = repeat track, 2 = repeat disc. 07 = Select. Next two bytes is the 16 bit item index. Selecting a track will play it. Selecting a folder will change to it. 08 = Shuffle mode. Next byte: 0 = no shuffle, 1 = shuffle tracks
Play status notification (**3E**)	2+ bytes	First byte is the source ID followed by status parameter and data: 00 = Play status flags: 1 data byte (1 = player available, 2 = loading directory, 4 = playback active, 8 = playback paused, 10h = reserved, 20h = repeat track, 40h = repeat disc, 80h = shuffle) 01 = Playlist length: 9 bytes total. 2 bytes for directory count, 2 bytes for file count, 2 bytes for previous directory index (after going back a directory only, otherwise FFFF) and 1 byte flags where bit 0 is set if there is a ".." directory. 02 = Playing track index: 2 data bytes for 16 bit index, numbered from 0. Always sent after the playlist length. Only sent if playing or paused. 03 = Playlist name: data is UTF-8 string. Automatic notifications for any changes to play status are sent to all zones using the source. 04 = Playlist item name: 2 data bytes for 16 bit index followed by UTF-8 string.
Play status request (**3F**)	2+ bytes	First byte is the source ID followed by one byte which is a bitmap of parameters to query (bit 0 = play status flags, bit 1 = playlist length, etc). If the request is sent to all zones, the responses are sent to all zones using the source. Otherwise the responses are sent to the zone sending the request. If parameter 4 (playlist item name) is selected, 4 bytes are required for start – end indexes after the parameter bitmap.
Report message (**40**)	2+ bytes	First byte is message type: 00 = Information 01 = Error 02 = Success Followed by UTF-8 string. Sent to whichever zones and interfaces are relevant.
Request time (**41**)	1 byte in request, 7 bytes in response	Requests the time. 00 = Immediately, 01 = the next time it changes. The response contains the time in UTC if available: • Hours (0..23 decimal) • Minutes (0..59 decimal) • Seconds (0..59 decimal) • Weekday (0 = Sun, 1 = Mon, .., 6 = Sat). Lower 3 bits

		only. Bit 4 is set for UTC and clear for local time. • Day (1..31) • Month (1..12) • Year (0..255, where 0 = 2000)

Notes:

- AX450I, AX4750I and all later amplifiers ignore standby B commands.
- 'Standby On' commands imply that the amplifier is not muted if the amplifier was previously off. A mute command must follow the standby command if it should be muted.
- The Volume Up and Volume down commands increment or decrement the amplifiers volume at each command string reception. Therefore to achieve a volume ramp, the commands must be sent continuously for the duration of the ramp.
- If a keypad is attached to an Axium amplifier then it is possible to control the keypad using the "Emulate key press on Keypad" command. The command includes a repeat code and a key code in the data byte. (e.g. **F4** means press the stop key and repeat 7 times.) If the repeat code is 0 the function will be repeated indefinitely, or until another "Emulate key press on Keypad" command is received with a data byte = **00**. Continuous commands are not good practice – however they may be used for volume Up / down ramp functions.
- All tracking modes require some intelligence on the part of the receiver. This means that a device transmitting a command does not need to account for all tracking modes and settings that it is perhaps not aware of. This is important because not all devices have sufficient memory to store all the settings for all zones. Furthermore, it means that devices only need to query the parameters for zones that they are interested in, thus reducing traffic when a device goes on line or is set to a zone.

  - Zone linking behaviour

    The "Link zone pair" command tells the zone specified in the zone byte "A" to follow the settings in the zone to be linked "B". However it also implicitly tells zone "B" to follow "A". Likewise if a link zone command is transmitted that either terminates the zone linking or tells either zones "A" or "B" to link to another, then both zones "A" and "B" are to stop tracking each other. Similar behaviour is expected when tracking the settings, if zone "A" changes its source, volume, mute, Preamp tracking mode/offset or standby settings, devices on zone "B" are expected to synchronise their internal settings and without sending notifications of any changes on zone "B". It is not the responsibility of the device on zone "A" that is making the change to inform zone "B" of any changes and it is not the responsibility of devices on zone "B" to inform of changes resulting from a change on zone "A".

    The "Link zones" commands tells all the zones in the command to be linked into one group. Commands sent to any of the zones in the group cause all the zones in the group to implicitly track the change. Devices therefore need to know about all the zones in the group, even if they are otherwise not used by the device. In addition, devices reporting its linked zones using this command must be able to list zones in the group that are not used by the device.

  - Amp / Preamp volume tracking behaviour

    As with zone linking, when Amp / Preamp volume tracking is set up, the receiver is expected to understand the meaning of a volume command, even if the command is directed to the "other side". For example: if the amplifier volume is changed and volume tracking is set up with an offset, any devices showing the Preamp volume are expected to receive the command informing of a change to the amplifier volume, add the offset and display the new Preamp volume. This is particularly important when zone linking includes the volume linking option. For example if zones A and B are volume linked and the Amp / Preamp volume tracking is set: A single command informing of a change to the amplifier volume on zone A not only implies a

change to the amplifier volume on zone B but also implies a change to the Preamp volume on zones A and B.

- The “no operation” command is useful for resetting the receive status of the amplifier after long periods or when random signals could have been transmitted to it (e.g. when booting the computer controlling the amplifier). The zone and data byte should be 00.

- The first byte of the response to the “request device information” has the following values:
  - 00 = amplifier
  - 01 = keypad
  - 02 = remote control
  - 03 = video switch
  - FF = no device

- The third byte of the response to the “request device information” has the following meanings for the amplifier when bit 7 is 0:
  - Bit 0 & 1: number of amplifiers – 1 (00 = AX50i, 01 = AX250i, 11 = AX450i)
  - Bit 2: 0 = 4 sources, 1 = 8 sources
  - Bit 7 = 0

- The third byte of the response to the “request device information” has the following meanings for the amplifier when bit 7 is 1:
  - 80h = ax4750
  - 81h = ax4752
  - 82h = mza-4.7
  - 83h = 451/452-AV
  - 84h = AX-800DAV (8 zones, 8 sources)
  - 85h = Vantage 850 (8 zones, 12 sources)
  - 86h = AX-400DA (4 zones, 6 sources)

- The third byte of the response to the “request device information” has the following meanings for the keypad:
  - Bit 0: 0 = 16kB, 1 = 32kB EEPROM
  - Bit 1: 1 when the KRXs is connected
  - Bit 2: 1 when leaving Network Programming Mode, otherwise 0.

- The third byte of the response to the “request device information” has the following meanings for the remote:
  - Bit 0: 0 = 16kB, 1 = 32kB EEPROM

- The preset schedule command is only valid when preset 1 or 2 is currently being configured.

- The “Send all parameters” command applies to amp/preamp groups and not to individual rooms. The preamp bit of the zone byte is ignored.

IR Function Definition

Function definitions are sent using multiple packets where the data block can be up to 19 bytes. The first two data bytes of each packet contain the device ID followed by one byte containing the number of bytes already transmitted for the definition. Remaining bytes are as follows:

1. Bank, one byte

2. Key, one byte

3. Dual command index and dual command delay, one byte. Lower 4 bits: 0 = regular, 1 = long press, upper 4 bits is the delay.

4. KRXm: Modulation period in 0.2µs (4 cycles @ 20MHz) units, one byte. 0 when no modulation is used, **FF** when command is undefined in which case, no bytes follow.
   AX-KPB: Modulation period in 0.0833µs (4 cycles @ 48MHz) units, two bytes. 0 when no modulation is used, **FFFF** when command is undefined in which case, no bytes follow.
5. Format, one byte. Has the following meanings:
   - 0 = one word that repeats
   - 1 = a start word is followed by a 'keep alive' code that repeats
   - 2 = two words that repeatedly alternate
   - 3 = one code followed by nothing
6. Macro information, one byte. Bit 0 is set when the function is the first in a macro (or is not a macro). Bit 1 is set when another function follows this one, in which case the next function begins with a new packet where the byte count parameter is zero. Bit 2 is set when alternating macro. Bits 4-7 are the number of repeats before sending the next command in a sequential macro.
7. Period lengths, 16 x 2 bytes (words). This array contains the times used in the IR stream. Times are in 0.8 µs (16 cycles @ 20MHz) for the KRXm and are in 0.333µs on the AX-KPB (16 cycles @ 48MHz). The last two times are the delays between the 1st & 2nd words and between following words, respectively. The delay time units are 256 times longer than the other times. The first byte of each word is the high byte. Not all period lengths need to be sent if many of them are zero. Therefore the receiver should initialise its array of period lengths to zero before receiving the function definition.
8. Period IDs, up to 80 bytes. This array stores references to the 16 available period lengths. Each byte has two references; the upper 4 bits represent periods of IR activity, and the lower 4 bits periods of no activity. The sequence ends when the lower 4 bits = 0Eh when the format is a single word format (0 or 3) or when the lower 4 bits = 0Fh.

PCM

PCM capabilities for a specific device and purpose can be queried using the “Request PCM capabilities” command. The device responds with its available memory, supported formats and maximum packet size. If a device returns 0000 for its available memory then this implies that the PCM data are not stored in memory and are not subject to memory constraints. In this case the PCM data are typically played immediately. The device also returns the largest packets it can accept where this implies a direct link to the device since any devices relaying the packets may impose restrictions of their own.

Purpose byte:

- **01** – paging (“doorbell”) sound
- **02** – second paging (“doorbell”) sound

Format bytes:

- **00** – PCM features not supported
- **01** – 11 kHz, 8 bit mono PCM
- **02** – 8 kHz, 8 bit mono PCM
- **03** – 22 kHz, 8 bit mono PCM
- **04** – 16 kHz, 8 bit mono PCM
- **05** – 32 kHz, 8 bit mono PCM
- **06** – 44 kHz, 8 bit mono PCM
- **07** – 48 kHz, 8 bit mono PCM
- **08** – 32 kHz, 16 bit mono PCM
- **09** – 44 kHz, 16 bit mono PCM
- **0A** – 48 kHz, 16 bit mono PCM

- **0B** – 32 kHz, 16 bit stereo PCM
- **0C** – 44 kHz, 16 bit stereo PCM
- **0D** – 48 kHz, 16 bit stereo PCM

Keypad key codes

An Axium Keypad may be directed to emit its learnt IR commands via RS232 control. This is achieved by sending a 'Emulate key press on Keypad' command, followed by the zone and the Keypad key code (data). The Keypad key code is encoded with IR string repeats. (See table below)

To terminate a continuously repeating 'Emulate Key press on keypad' command a **00** code must be sent for the KRX, and a **FF** code sent for the KRXm and AX-KPB keypads.

All Codes are Hex.

KRX								
REPEATS								**KEY**
Continuous	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
00	**-**	**-**	**-**	**-**	**-**	**-**	**-**	Stops repeating the current key
01	**21**	**41**	**61**	**81**	**A1**	**C1**	**E1**	Aux
02	**22**	**42**	**62**	**82**	**A2**	**C2**	**E2**	Tuner
03	**23**	**43**	**63**	**83**	**A3**	**C3**	**E3**	CD Bank
04	**24**	**44**	**64**	**84**	**A4**	**C4**	**E4**	CD
05	**25**	**45**	**65**	**85**	**A5**	**C5**	**E5**	Vol Up
06	**26**	**46**	**66**	**86**	**A6**	**C6**	**E6**	Ch Up (2)
07	**27**	**47**	**67**	**87**	**A7**	**C7**	**E7**	Random (1)
08	**28**	**48**	**68**	**88**	**A8**	**C8**	**E8**	Play
09	**29**	**49**	**69**	**89**	**A9**	**C9**	**E9**	Power
0A	**2A**	**4A**	**6A**	**8A**	**AA**	**CA**	**EA**	+ Track skip (0)
0B	**2B**	**4B**	**6B**	**8B**	**AB**	**CB**	**EB**	- Track skip (9)
0C	**2C**	**4C**	**6C**	**8C**	**AC**	**CC**	**EC**	Disc skip
0D	**2D**	**4D**	**6D**	**8D**	**AD**	**CD**	**ED**	Mute
0E	**2E**	**4E**	**6E**	**8E**	**AE**	**CE**	**EE**	Fast Forward (8)
0F	**2F**	**4F**	**6E**	**8F**	**AF**	**CF**	**EF**	Rewind (7)
10	**30**	**50**	**70**	**90**	**B0**	**D0**	**F0**	Pause (6)
11	**31**	**51**	**71**	**91**	**B1**	**D1**	**F1**	Vol Down
12	**32**	**52**	**72**	**92**	**B2**	**D2**	**F2**	Ch Down (5)

13	**33**	**53**	**73**	**93**	**B3**	**D3**	**F3**	Band (4)
14	**34**	**54**	**74**	**94**	**B4**	**D4**	**F4**	Stop (3)
KRXm								
REPEATS								**KEY**
Continuous	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
00	**20**	**40**	**60**	**80**	**A0**	**C0**	**E0**	Volume Down
01	**21**	**41**	**61**	**81**	**A1**	**C1**	**E1**	Volume Up
02	**22**	**42**	**62**	**82**	**A2**	**C2**	**E2**	DVD
03	**23**	**43**	**63**	**83**	**A3**	**C3**	**E3**	Aux
04	**24**	**44**	**64**	**84**	**A4**	**C4**	**E4**	MCD
05	**25**	**45**	**65**	**85**	**A5**	**C5**	**E5**	DMS
06	**26**	**46**	**66**	**86**	**A6**	**C6**	**E6**	Tuner
07	**27**	**47**	**67**	**87**	**A7**	**C7**	**E7**	CD
08	**28**	**48**	**68**	**88**	**A8**	**C8**	**E8**	Play
09	**29**	**49**	**69**	**89**	**A9**	**C9**	**E9**	Fast Forward
0A	**2A**	**4A**	**6A**	**8A**	**AA**	**CA**	**EA**	Standby
0B	**2B**	**4B**	**6B**	**8B**	**AB**	**CB**	**EB**	Down
0C	**2C**	**4C**	**6C**	**8C**	**AC**	**CC**	**EC**	Up
0D	**2D**	**4D**	**6D**	**8D**	**AD**	**CD**	**ED**	Mute
0E	**2E**	**4E**	**6E**	**8E**	**AE**	**CE**	**EE**	Rewind
0F	**2F**	**4F**	**6E**	**8F**	**AF**	**CF**	**EF**	Pause/Stop
10	**30**	**50**	**70**	**90**	**B0**	**D0**	**F0**	1
11	**31**	**51**	**71**	**91**	**B1**	**D1**	**F1**	4
12	**32**	**52**	**72**	**92**	**B2**	**D2**	**F2**	7
13	**33**	**53**	**73**	**93**	**B3**	**D3**	**F3**	-/--
14	**34**	**54**	**74**	**94**	**B4**	**D4**	**F4**	Disc
15	**35**	**55**	**75**	**95**	**B5**	**C5**	**F5**	Select
16	**36**	**56**	**76**	**96**	**B6**	**C6**	**F6**	Group
17	**37**	**57**	**77**	**97**	**B7**	**C7**	**F7**	Random

18	**38**	**58**	**78**	**98**	**B8**	**C8**	**F8**	2
19	**39**	**59**	**79**	**99**	**B9**	**C9**	**F9**	5
1A	**3A**	**5A**	**7A**	**9A**	**BA**	**CA**	**FA**	8
1B	**3B**	**5B**	**7B**	**9B**	**BB**	**CB**	**FB**	0
1C	**3C**	**5C**	**7C**	**9C**	**BC**	**CC**	**FC**	3
1D	**3D**	**5D**	**7D**	**9D**	**BD**	**CD**	**FD**	6
1E	**3E**	**5E**	**7E**	**9E**	**Be**	**CE**	**FE**	9
1F	**3F**	**5F**	**7F**	**9F**	**BF**	**CF**	**-**	AV
FF	**-**	**-**	**-**	**-**	**-**	**-**	**-**	Stops continuous key press

AX-KPB								
REPEATS								**KEY**
Continuous	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
00	**20**	**40**	**60**	**80**	**A0**	**C0**	**E0**	Bank 6 (DVD)
01	**21**	**41**	**61**	**81**	**A1**	**C1**	**E1**	Bank 5 (AUX)
02	**22**	**42**	**62**	**82**	**A2**	**C2**	**E2**	Bank 4 (DMS)
03	**23**	**43**	**63**	**83**	**A3**	**C3**	**E3**	Bank 3 (Cable)
04	**24**	**44**	**64**	**84**	**A4**	**C4**	**E4**	Bank 2 (Tuner)
05	**25**	**45**	**65**	**85**	**A5**	**C5**	**E5**	Bank 1 (CD)
08	**28**	**48**	**68**	**88**	**A8**	**C8**	**E8**	Volume Up
09	**29**	**49**	**69**	**89**	**A9**	**C9**	**E9**	Axium Standby Command
0A	**2A**	**4A**	**6A**	**8A**	**AA**	**CA**	**EA**	Axium Mute Command
0C	**2C**	**4C**	**6C**	**8C**	**AC**	**CC**	**EC**	Volume Down
0E	**2E**	**4E**	**6E**	**8E**	**AE**	**CE**	**EE**	Standby/Mute
10	**30**	**50**	**70**	**90**	**B0**	**D0**	**F0**	5
11	**31**	**51**	**71**	**91**	**B1**	**D1**	**F1**	4
12	**32**	**52**	**72**	**92**	**B2**	**D2**	**F2**	3
13	**33**	**53**	**73**	**93**	**B3**	**D3**	**F3**	2
14	**34**	**54**	**74**	**94**	**B4**	**D4**	**F4**	1

15	**35**	**55**	**75**	**95**	**B5**	**D5**	**F5**	Skip
16	**36**	**56**	**76**	**96**	**B6**	**D6**	**F6**	Stop
17	**37**	**57**	**77**	**97**	**B7**	**D7**	**F7**	Play
18	**38**	**58**	**78**	**98**	**B8**	**D8**	**F8**	0
19	**39**	**59**	**79**	**99**	**B9**	**D9**	**F9**	9
1A	**3A**	**5A**	**7A**	**9A**	**BA**	**DA**	**FA**	8
1B	**3B**	**5B**	**7B**	**9B**	**BB**	**DB**	**FB**	7
1C	**3C**	**5C**	**7C**	**9C**	**BC**	**DC**	**FC**	6
1D	**3D**	**5D**	**7D**	**9D**	**BD**	**DD**	**FD**	-Track
1E	**3E**	**5E**	**7E**	**9E**	**BE**	**DE**	**FE**	Pause
1F	**3F**	**5F**	**7F**	**9F**	**BF**	**DF**	**-**	+Track
FF	**-**	**-**	**-**	**-**	**-**	**-**	**-**	Stops continuous key press